


<b>AWARD/CONTRACT</b>		1. THIS CONTRACT IS A RATED ORDER UNDER DPAS (15 CFR 700)		RATING		PAGE OF PAGES 1   2	
2. CONTRACT (Proc. Inst. Ident.) NO. EP-C-17-031/68HERC22F0088				3. EFFECTIVE DATE See Block 20C		4. REQUISITION/PURCHASE REQUEST/PROJECT NO. PR-ORD-22-00005	
5. ISSUED BY CODE CAD US Environmental Protection Agency 26 West Martin Luther King Drive Mail Code: W136 Cincinnati OH 45268-0001		6. ADMINISTERED BY (If other than Item 5) CODE					
7. NAME AND ADDRESS OF CONTRACTOR (No., street, country, State and ZIP Code)  TETRA TECH, INC. Attn: George Townsend 10306 EATON PL STE 340 FAIRFAX VA 22030				8. DELIVERY <input type="checkbox"/> FOB ORIGIN <input checked="" type="checkbox"/> OTHER (See below)			
				9. DISCOUNT FOR PROMPT PAYMENT			
				10. SUBMIT INVOICES (4 copies unless otherwise specified) TO THE ADDRESS SHOWN IN		ITEM	
CODE 198549560		FACILITY CODE					
11. SHIP TO/MARK FOR CODE ORD DC Office of Research and Development US Environmental Protection Agency 1200 Pennsylvania Avenue, NW MC: 8101R Washington DC 20460		12. PAYMENT WILL BE MADE BY CODE					
13. AUTHORITY FOR USING OTHER THAN FULL AND OPEN COMPETITION: <input type="checkbox"/> 10 U.S.C. 2304 (c) ( ) <input checked="" type="checkbox"/> 41 U.S.C. 3304 (a) ( 1 )				14. ACCOUNTING AND APPROPRIATION DATA See Schedule			
15A. ITEM NO	15B. SUPPLIES/SERVICES			15C. QUANTITY	15D. UNIT	15E. UNIT PRICE	15F. AMOUNT
	Continued						
15G. TOTAL AMOUNT OF CONTRACT						\$393,694.75	
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<b>CONTRACTING OFFICER WILL COMPLETE ITEM 17 (SEALED-BID OR NEGOTIATED PROCUREMENT) OR 18 (SEALED-BID PROCUREMENT) AS APPLICABLE</b>							
17. <input checked="" type="checkbox"/> CONTRACTOR'S NEGOTIATED AGREEMENT (Contractor is required to sign this document and return _____ copies to issuing office.) Contractor agrees to furnish and deliver all items or perform all the services set forth or otherwise identified above and on any continuation sheets for the consideration stated herein. The rights and obligations of the parties to this contract shall be subject to and governed by the following documents: (a) this award/contract, (b) the solicitation, if any, and (c) such provisions, representations, certifications, and specifications, as are attached or incorporated by reference herein. (Attachments are listed herein.)				18. <input type="checkbox"/> SEALED-BID AWARD (Contractor is not required to sign this document.) Your bid on Solicitation Number 68HERC22R0015, including the additions or changes made by you which additions or changes are set forth in full above, is hereby accepted as to the items listed above and on any continuation sheets. This award consummates the contract which consists of the following documents: (a) the Government's solicitation and your bid, and (b) this award/contract. No further contractual document is necessary. (Block 18 should be checked only when awarding a sealed-bid contract.)			
19A. NAME AND TITLE OF SIGNER (Type or print)				20A. NAME OF CONTRACTING OFFICER Mark Cranley			
19B. NAME OF CONTRACTOR TETRA TECH, INC.		19C. DATE SIGNED		20B. UNITED STATES OF AMERICA BY  (Signature of the Contracting Officer)		20C. DATE SIGNED 12/10/2021	
BY _____ (Signature of person authorized to sign)							

<b>CONTINUATION SHEET</b>	REFERENCE NO. OF DOCUMENT BEING CONTINUED EP-C-17-031/68HERC22F0088	PAGE	OF
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NAME OF OFFEROR OR CONTRACTOR  
TETRA TECH, INC.

ITEM NO. (A)	SUPPLIES/SERVICES (B)	QUANTITY (C)	UNIT (D)	UNIT PRICE (E)	AMOUNT (F)
0001	<p>DUNS Number: 198549560 TOCOR: Thomas Johnson Alt Invoice App: Britta Bierwagen Delivery: 12/16/2022 Period of Performance: 12/17/2021 to 12/16/2022</p> <p>New FFP CLIN for Climate Assessment Product in accordance with the attached PWS Product/Service Code: R499</p> <p>Accounting Info: 21-22-C-26D2000-000FK6XR1-2532-26A5C-2226D2CR03-001 1 BFY: 21 EFY: 22 Fund: C Budget Org: 26D2000 Program (PRC): 000FK6XR1 Budget (BOC): 2532 Cost: 26A5C DCN - Line ID: 2226D2CR03-001 Funding Flag: Complete Funded: \$279,735.00</p> <p>Accounting Info: 21-22-C-26D2000-000FK6XR2-2532-26A5C-2226D2CR03-002 2 BFY: 21 EFY: 22 Fund: C Budget Org: 26D2000 Program (PRC): 000FK6XR2 Budget (BOC): 2532 Cost: 26A5C DCN - Line ID: 2226D2CR03-002 Funding Flag: Complete Funded: \$22,000.00</p> <p>Accounting Info: 21-22-C-26D2000-000FK7XR4-2532-26A5C-2226D2CR03-003 3 BFY: 21 EFY: 22 Fund: C Budget Org: 26D2000 Program (PRC): 000FK7XR4 Budget (BOC): 2532 Cost: 26A5C DCN - Line ID: 2226D2CR03-003 Funding Flag: Complete Funded: \$32,000.00</p> <p>Accounting Info: 21-22-C-26D2000-000FK7XR4-2532-26A6F-2226D2CR03-004 4 BFY: 21 EFY: 22 Fund: C Budget Org: 26D2000 Program (PRC): 000FK7XR4 Budget (BOC): 2532 Cost: 26A6F DCN - Line ID: 2226D2CR03-004 Funding Flag: Complete Funded: \$59,959.75</p>				393,694.75

**PERFORMANCE WORK STATEMENT**  
**Contract Number (Tetra Tech, Inc.) EP-C-17-031**  
**PR-ORD-22-00005**  
**TO # 68HERC22F0088**

**I. TITLE:** Climate Assessment Products

**II. EAS SHORT TITLE:** Climate Assessment Products

**III. TASK ORDER COR:**

<b>Task Order COR (TOCOR)</b>	<b>Alternate Task Order COR (ATOCOR)</b>
Name: Thomas Johnson Office: ORD/CPHEA/IEAB-D 1200 Pennsylvania Ave., NW (MC 8623R) Washington, DC 20460 Phone: 202-564-6677 Email: Johnson.thomas@epa.gov	Name: Britta Bierwagen Office: ORD/CPHEA/IEAB-D 1200 Pennsylvania Ave., NW (MC 8623R) Washington, DC 20460 Phone: 202-564-7676 Email: Bierwagen.britta@epa.gov

**IV. PERIOD OF PERFORMANCE:** Date of Task Order award through 12 months.

**V. BACKGROUND:**

The EPA Office of Research and Development's Integrated Environmental Assessment Branch-DC works to build the capacity of EPA program and regional offices, water managers, and other decision-makers to assess and respond to changes in climatic conditions and events that affect water quality and aquatic ecosystems. Research and assessment activities broadly support EPA's mission and responsibilities as defined by the Clean Water Act and the Safe Drinking Water Act. IEAB conducts innovative synthesis, assessment, and research to fill critical knowledge gaps by working with stakeholders and partners to identify and address both near- and long-term challenges associated with a changing environment.

During the last century, much of the U.S. experienced warming temperatures, increases in precipitation, sea level rise and increases in the intensity of precipitation events. These changes are expected to continue in the future leading to increased risk of impacts to water, watersheds, safe drinking water and aquatic ecosystems throughout the U.S. Responding to this challenge requires improved understanding of potential impacts in different regional and watershed settings, and development of management strategies to reduce vulnerabilities across a range of possible climate futures.

This Task Order supports EPA ORD research and assessment activities addressing climate change risk in 4 areas: (1) water quality management, (2) aquatic biota and biomonitoring programs, (3) harmful algal blooms (HABs) and (4) drinking water systems.

Water Quality Management

In 2017, EPA developed a draft web site as a national-scale assessment of potential climate change effects on water quality, known as the Water Quality Climate Literature Review (WQCLR). The site provides syntheses of technical literature addressing climate change and different attributes of water quality. Technical information can be accessed by water quality topic (streamflow, nutrients, water temperature, pathogens, aquatic communities, sediment, sea level rise, frameworks for assessing vulnerability, and scenarios), geographic region, or relevance to different EPA water programs (e.g., stormwater, NPDES, TMDL, drinking water). The site also provides links to online tools, data and case studies to guide users in conducting vulnerability and adaptation assessments in specific geographic locations. The WQCLR site was available internally on EPA's intranet, but not on the EPA public site. EPA is now planning to release the WQCLR on EPA's public web site. Prior to release, there is a need to review the current site content (developed in 2017) and identify any errors and priority/feasible text revisions.

In addition to the WQCLR, EPA ORD is conducting related work that investigates the effectiveness of different water quality management practices for reducing anticipated climate change impacts. EPA has completed 3 draft manuscripts intended for publication in peer reviewed journals. Revisions to each manuscript are needed to address peer review comments.

#### Aquatic Biota and Biomonitoring Programs

This Task Order (TO) supports regional monitoring networks (RMN) in general, and specifically the development of a Region 3 Wetlands RMN, as well as additional work on expected community composition changes as a result of climate change effects. EPA's Office of Water (OW) and regional, state, tribal, and local water resource managers are the primary audiences for this work. Specific tasks Wetlands Regional Monitoring Network for EPA Regions 2 and 3, and advancing modeling of community composition changes resulting from climate change impacts, particularly for the Maritime BCG.

#### HABs Risk

Climate change has been linked to an increased risk of HAB events (Smucker et al. 2021 <https://doi.org/10.1111/gcb.15618>). Current research (e.g. Rouso et al. 2020 <https://doi.org/10.1016/j.watres.2020.115959>) suggests that water temperature is the single most important predictor of bloom risk. The effects of warmer water are expressed via at least two pathways. First, various cyanobacteria species are better adapted to warm water temperatures than most other algae. Second, stable stratified conditions over longer periods of time play to the competitive advantage of cyanophytes that can adjust buoyancy to vary their position in the water column, enabling them to move to the optimal photic depth during the day and sink to the nutrient rich metalimnion during the night. The water column stability angle means that lake morphometry and wind stresses will also contribute to cyanophyte bloom risk. Nutrient enrichment also plays a role in cyanophyte blooms, with the worst cyanotoxin events typically associated with lakes that have greater external and internal nutrient loads. The influence of nutrients is likely modulated by both water column stability and lake morphometry, as well as hydraulic residence time and the amount of phosphorus stored in the sediments.

Much current research in the U.S. is focused on the short-term prediction of HABs, e.g., by integrating remote sensing with other risk factors. The short-term prediction problem is essential for providing early warning to water utilities; however, work is also needed on the



longer-term (e.g., multi-decadal) evaluation of how risks of such events may change under an evolving climate. This work will help identify the risk factors and classes of lakes that will be most sensitive to increases in temperature. Increases in temperature, along with other factors, may exacerbate HAB formation in nutrient-enriched lakes, while also resulting in strong responses by cold-water lakes due to the greater change in temperature relative to baseline conditions (Mantzouki et al. 2018). Past ORD work on lakes is well suited to address both the water temperature and stability/overtake frequency components of the risk. Past ORD work on future changes in pollutant loads in 20 U.S. watersheds also ties in well with this topic.

#### Risk to Drinking Water

Climate change has the potential to impact drinking water supplies across the United States, with implications for human health. The top five contaminants with the most human health-based violations of their drinking water standards include nitrate, disinfection byproducts, arsenic, total coliforms, lead & copper (Allaire et al. 2018, Pennino et al. 2017). Many of these contaminants are of concern due to their association with cancers and other diseases (Ward et al. 2005, Richardson et al. 2007).

Increased frequency of rain events or periods of drought could impact drinking water supplies through impacting source water quality, such as with increased contaminant pulses (Kaushal et al. 2010) and the ability of individual public water systems (PWS) to treat and/or handle more rapid changes in source water quality, such as higher sediment loads (Coffey et al. 2019) or damage to the PWS distribution system. Also, wildfires, which are expected to increase due to climate change have been shown to impact the drinking water contaminants nitrate, disinfection byproducts, and arsenic (Pennino et al. 2020, Hohner et al. 2019, Sham et al. 2013).

It will be important to know which areas are most vulnerable to climate change. The public water systems in certain communities may be more at risk to increased rain or drought. Currently, many of the areas with the highest health-based violation rates are in rural areas or potentially economically vulnerable communities (Pennino et al. 2017, Allaire et al. 2018).

While studies have assessed the risk for elevated contaminant levels (Pennino et al. 2020, Wheeler 2015, Ayotte et al. 2017), no studies have looked at how future risk to drinking water supplies may change due to projected climate change scenarios.

The objective of this project is to expand upon the analysis of Pennino et al. 2020, which predicted the risk of nitrate violations for locations across the conterminous United States, by updating random forest model predictor variables with future projected temperature, precipitation, land use, and nitrogen input data based on future climate scenarios. Additionally, projected future changes in temperature, precipitation, and land use / land cover (e.g. impervious surfaces and human infrastructure) will be used to model the future risk to other drinking water contaminants, such as lead, copper, arsenic, disinfection byproducts, and total coliform.

#### **VI. PURPOSE OF THIS TASK ORDER (TO):**

This Task Order supports EPA ORD research and assessment activities addressing climate change risk in 4 areas:

(1) water quality management (Tasks 2 and 3)

- (2) aquatic biota and biomonitoring programs (Tasks 4, 5, 6, and 9)
- (3) HABs (Task 7)
- (4) drinking water systems (Task 8)

## **VII. DESCRIPTION OF TASKS:**

### **Task 1: Communication and QAPP development**

#### **SubTask 1.1. Communication and Regular Reporting**

The contractor shall schedule monthly project meetings throughout the period of performance of this Task Order. Additional meetings shall be scheduled as necessary when requested by the TOCOR.

*Deliverable 1.1.A:* Monthly conference calls to provide status updates. Due each month for the duration of this TO or as requested by the TOCOR.

*Deliverable 1.1.B:* Each monthly conference call shall be reported in meeting notes as email and sent to the TOCOR within three (3) days of the monthly call.

#### **SubTask 1.2. Develop a QAPP**

All work conducted under this task order shall be performed pursuant to an EPA-approved Quality Assurance Project Plan (QAPP). The draft QAPP with EPA QA ID: L-HEEAD-0033275-QP-1-0, shall be submitted for review to the TOCOR and the EPA QA Manager 14 days after TO award. The draft QAPP shall be in conformance with EPA's *Requirements for Quality Assurance Project Plans* (EPA QA/R-5). (<https://www.epa.gov/quality/epa-qar-5-epa-requirements-quality-assurance-project-plans>)

All electronic deliverables (i.e., computer files) shall be submitted in a format acceptable to EPA.

Tasks 2 through 9 may not begin until receiving in writing from the EPA TOCOR that EPA QA has approved the QAPP.

*Deliverable 1.2.A:* Draft QAPP submitted to the TOCOR for review 14 days after TO award.

*Deliverable 1.2.B:* Final QAPP addressing TOCOR's and QA officer's comments on the QAPP due one (1) week after receiving comments from the TOCOR.

### **Task 2 – Review draft WQCLR site content and identify errors that need revision**

In 2017, EPA developed a draft web site as a national-scale assessment of potential climate change effects on water quality, known as the Water Quality Climate Literature Review (WQCLR). The site provides syntheses of technical literature addressing climate change and different attributes of water quality. Technical information can be accessed by water quality topic (streamflow, nutrients, water temperature, pathogens, aquatic communities, sediment,

sea level rise, frameworks for assessing vulnerability, and scenarios), geographic region, or relevance to different EPA water programs (e.g., stormwater, NPDES, TMDL, drinking water). The site also provides links to online tools, data and case studies to guide users in conducting vulnerability and adaptation assessments in specific geographic locations. The WQCLR site has been available internally to EPA staff, but was never posted on EPA's public site. EPA now plans to release the WQCLR on EPA's public web site. Prior to release, there is a need to review the current site content (developed in 2017) and identify any critical errors and feasible revisions that can be made.

The Contractor shall, in consultation with the TOCOR, review the content of the draft WQCLR web site and identify any critical errors and necessary/feasible revisions that can be made prior to release as a public web site. Updates are anticipated to include a limited set of text edits to statements that are now inappropriate or out-of-date, and updates of "broken" links where links to other web sites are no longer active. Upon completion of this review, the Contractor shall compile a draft, itemized list of broken links, reference to outdated information and other text errors that can feasibly be corrected for TOCOR review. TOCOR will provide comments on the draft list. The Contractor shall then complete a final, itemized list of errors and proposed revised language to correct errors.

*Deliverable 2.1:* Draft itemized list of errors and proposed corrections to the WQCLR site. Due to TOCOR 8 weeks after award.

*Deliverable 2.2:* Final itemized list of errors and proposed corrections to the WQCLR site. Due 4 weeks after receiving TOCOR comments on Deliverable 2.1.

### **Task 3: Revise manuscripts to address peer review comments**

#### **SubTask 3.1. National stormwater screening manuscript**

ORD is developing a "national screening stormwater" manuscript addressing the effects of future changes in rainfall events (e.g. design storms) on urban stormwater BMPs in different regions of the country. Previous work under TO 19F0007; EP-C-17-031 will result in the completion of a first draft manuscript. The first draft manuscript must undergo 2 (two) separate sets of technical peer review comments; first an internal review by 2 (two) EPA scientists, and second review by a peer reviewed scientific journal. This task is for revision to address each set of peer review comments.

The TOCOR will provide the Contractor with peer review comments from 2 (two) EPA experts on the first draft national stormwater screening manuscript. The Contractor shall, upon receiving EPA internal peer review comments, revise the first draft manuscript to address internal EPA peer review comments, leading to a second draft manuscript suitable for submission to a peer reviewed journal.

The second draft manuscript will then undergo peer review by a peer reviewed scientific journal. If the manuscript is accepted by the journal, the Contractor shall, upon receiving journal peer review comments, revise the second draft manuscript to address journal peer comments, leading to a third draft manuscript suitable for re-submission to the journal. If the manuscript is rejected, the Contractor shall, in consultation with the TOCOR, re-format the second draft

manuscript leading to a third draft manuscript in a format specified by the TOCOR. All revisions shall be written in clear, concise prose consistent with the standards of peer reviewed scientific literature (e.g., suitable for publication in technical journals such as the Journal of the American Water Resources Association).

*Deliverable 3.1.A:* Second draft “national screening stormwater” manuscript addressing EPA internal review comments. Due to TOCOR 4 weeks after receiving EPA internal peer review comments from the TOCOR.

*Deliverable 3.1.B:* Third draft “national screening stormwater” manuscript addressing journal peer review comments. Due to TOCOR 4 weeks after receiving peer review comments from the journal.

### **SubTask 3.2. Revise BMP resilience and RDM manuscripts to address peer review comments**

Previous work under TO #68HERC19F0009 (EP-C-17-031) resulted in the completion of 2 (two) first draft manuscripts; a “BMP resilience” manuscript discussing the factors affecting BMP resilience to climate change, and an “RDM” manuscript explores the application of robust decision making concepts at different levels of complexity. Each manuscript was submitted for peer review and publication in scientific journals. Revisions to each manuscript are now required to address peer review comments.

#### **BMP resilience manuscript**

The TOCOR will provide the Contractor with peer review comments on the first draft BMP resilience manuscript from no more than 3 (three) reviewers. If the manuscript has been accepted for publication by a journal, the Contractor shall, upon receiving journal peer review comments, revise the first draft manuscript to address peer review comments, leading to a second draft manuscript suitable for submission to the journal. If the manuscript is rejected, the Contractor shall, in consultation with the TOCOR, re-format the first draft manuscript leading to a second draft manuscript in a format specified by the TOCOR. All revisions shall be written in clear, concise prose consistent with the standards of peer reviewed scientific literature (e.g., suitable for publication in technical journals such as the Journal of the American Water Resources Association).

*Deliverable 3.2.A:* Second draft “BMP resilience” manuscript addressing peer review comments. Due to TOCOR 4 weeks after receiving peer review comments.

#### **RDM manuscript**

The TOCOR will provide the Contractor with peer review comments on the first draft RDM manuscript from no more than 3 (three) reviewers. If the manuscript has been accepted for publication by a journal, the Contractor shall, upon receiving journal peer review comments, revise the first draft manuscript to address peer review comments, leading to a second draft manuscript suitable for submission to the journal. If the manuscript is rejected, the Contractor shall, in consultation with the TOCOR, re-format the first draft manuscript leading to a second draft manuscript in a format specified by the TOCOR. All revisions shall be written in clear, concise prose consistent with the standards of peer reviewed scientific literature (e.g., suitable

for publication in technical journals such as the Journal of the American Water Resources Association).

*Deliverable 3.2.B:* Second draft “RDM” manuscript addressing peer review comments. Due to TOCOR 4 weeks after receiving peer review comments.

#### **Task 4 – Development of a Long-term Regional Monitoring Network for Wetlands in Regions 2 and 3**

There is a lack of long-term continuous data needed to detect and understand shifting baseline conditions in wetlands. Reference sites have long served as a standard against which to assess other waterbodies, but lack of understanding of long-term changes in these systems may undermine their utility for use in assessment, criteria development and other Clean Water Act protections. It is critical for monitoring programs to document current thermal and hydrologic regimes, identify how they are changing, and understand how these changes are affecting the condition of aquatic ecosystems. Understanding and tracking hydrologic changes are particularly important for wetlands. Altered patterns of precipitation, increasing temperatures, and related increases in evapotranspiration can result in changes in surface and ground water levels, where a change of only a few centimeters can have dramatic impacts on wetland size, characteristics, and ecosystems services provided. Effects will vary regionally and interact strongly with other human activities such as land use and water management.

This project will provide a framework for collection of long-term data in Region 3 reference quality wetlands through the development of a Regional Monitoring Network (RMN), filling a data gap that will subsequently allow us to understand how baseline conditions are shifting over time. This will give biological assessment programs the information needed to account for long-term changes in reference conditions, which is a need identified by state partners of Regions 2 and 3 in 2017. The products developed through this project, including protocol documents, a network of candidate sites, and quality assurance documents will provide the foundation for the RMN. There are existing long-term monitoring efforts in stream ecosystems in Region 3, as well as individual wetland monitoring efforts. However, there is no long-term wetland monitoring network across the Region that is using consistent methods to collect a set of data continuously. This effort will build upon the RMN developed by this team for Region 3 streams, as well as more recent efforts to implement a lake RMN in Region 3. The project will leverage methods developed for the EPA National Wetland Condition Assessment.

The goal of the Wetlands Regional Monitoring Network (WRMN) is to collect consistent data across sites in the Region and continuous data for critical hydrologic variables. Long-term data collection will include continuous water level, both surface and ground water, soil pits and soil profile, biotic surveys of plants, birds, and amphibians. Multiple indicators, such as species richness, soil saturation, and percent cover, can be calculated from these data to establish baseline conditions and track long-term changes. Importantly, the data will allow tracking of decoupling of hydrologic conditions and plant community composition. Region 3 does not have any comprehensive wetland monitoring programs. This project will be the first WRMN in the country and will serve as a template for other Regions.

Specifically, the Contractor shall:

- (1) develop screening criteria for inclusion of wetland sites,
- (2) conduct site screening,
- (3) develop a refined indicator list to inform data collection and a prioritized list of data collection protocols,
- (4) develop protocol documents and a Quality Assurance Project Plan (QAPP), and
- (5) propose a network of wetland sites for data collection.

For (1), the WRMN will use the wetlands classification from the National Aquatic Resource Surveys. Each wetland class will be screened for the Region to identify candidate sites for long-term monitoring. Screening criteria include considerations such as:

- Vulnerability to changing hydrology
- Locations of existing monitoring sites with historical data and collaboration potential
- Level of anthropogenic disturbance
- Representation of wetland class across the study area

For (3), Table 1 lists proposed indicators that can serve as the starting point.

Table 1: Data collection and proposed indicators from the data will come from continuous water level sensors, soil pits and profiles, and biotic surveys of plants, birds, and amphibians.

Group	Proposed indicators that can be calculated from the data
Hydrology (continuous water level)	<ul style="list-style-type: none"><li>• Hydroperiod</li><li>• GW/SW depths &amp; level changes</li><li>• Extent/duration of inundation (&amp; changes therein)</li><li>• Timing of seasonal inundation/drawdown</li><li>• Soil saturation</li><li>• Depth to GW</li><li>• Spring/summer water level differences</li><li>• % Time in upper 30cm during growing season</li><li>• GW fluctuations in the upper 30 cm</li></ul>
Soils (pit/profile)	<ul style="list-style-type: none"><li>• Soil morphology (texture, depth of layers, color)</li><li>• Carbon</li><li>• Organic matter</li><li>• Soil-hydrology-vegetation disconnect</li><li>• Soil salinity</li><li>• Soil temperature</li></ul>
Biota (plants, birds & amphibians)	<ul style="list-style-type: none"><li>• Species richness</li><li>• Community type changes, succession, disconnect/decoupling</li><li>• Various indices (e.g., FQAI)</li><li>• Invasives/exotics (abundance, % composition)</li><li>• Functional groups</li><li>• Ratio of annuals/perennials</li><li>• Ratio of C3/C4 plants</li></ul>

	<ul style="list-style-type: none"> <li>• Presence of rare/sensitive, native, T&amp;E species</li> <li>• % Cover - natives &amp; non-natives, disturbance tolerant plants</li> <li>• Species range shifts</li> <li>• Tree-sapling ratios</li> <li>• Tree death/standing dead</li> <li>• Habitat value/quality for wildlife</li> <li>• Decomposition rate</li> </ul>
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**Deliverable 4.1.A:** Screening criteria for inclusion of wetland sites. Due two (2) weeks after TO QAPP is approved.

**Deliverable 4.1.B:** Proposed list of sites based on Deliverable 4.1.A and map of those sites. Due two (2) weeks after Deliverable 4.1.A approved.

**Deliverable 4.1.C:** Webinar with state partners to get input on screening criteria and proposed sites. Due two (2) weeks after Deliverable 4.1.B approved.

**Deliverable 4.2:** Implement screening criteria and finalize proposed sites. Due two (2) weeks after Deliverable 4.1 approved.

**Deliverable 4.3.A:** Draft indicator list and protocols to collect the data for those indicators. Due one (1) month after Deliverable 4.2 approved.

**Deliverable 4.3.B:** Webinar with state partners to present draft indicator list and protocols. Due two (2) weeks after receiving TOCOR comments on Deliverable 4.3.A.

**Deliverable 4.4.A:** Develop draft protocol documents based on Deliverable 4.3.B. Due six (6) weeks after Deliverable 4.3.B.

**Deliverable 4.4.B:** Use Deliverable 4.4.A. to draft QAPP for state partners to use for data collection. Due one (1) month after receiving TOCOR comments on Deliverable 4.4.A.

**Deliverable 4.4.C:** Webinar with state partners to discuss Deliverables 4.4.A. and 4.4.B. Due two (2) weeks after receiving TOCOR comments on Deliverable 4.4.B.

**Deliverable 4.4.D:** Finalize protocol and QAPP documents based on Deliverable 4.4.C. Due one (1) month after Deliverable 4.4.C.

**Deliverable 4.5:** Present network of sites to state partners. Due two (2) weeks after receiving TOCOR comments on Deliverable 4.4.B.

## **Task 5 – Analytical support of and trainings for Stream and Lake Regional Monitoring Networks (RMNs)**

This task provides analytical support (e.g., taxonomic harmonization across entities within an RMN, populating regional trait tables, continued QA/QC and data analysis support), partner

trainings through webinars and workshop participation, and contributions to EMVL tool development and lake and stream R tool improvements (based on the R tools in TO # 68HERC20F0434, Task 4).

***Deliverable 5.1:*** Monthly memo describing support activities and summarizing conference call or webinar discussions with RMN partners and RMN Regional leads. Due monthly.

***Deliverable 5.2:*** Work with RMN partner states to prepare their data to be sent to EPA to incorporate into the tool development effort through EMVL. Due 8 weeks after QAPP approval.

***Deliverable 5.3:*** Conference or workshop presentations for and participation in three regional conferences, such as NEAB, AMMAB, SWPBA, selected with TOCOR input to provide status updates to the RMN partners. Due three (3) weeks before each conference.

***Deliverable 5.4.A:*** Hold RMN partner webinar to elicit input on R tool improvements. Due 12 weeks after QAPP approval.

***Deliverable 5.4.B:*** Complete R tool improvements based on Deliverable 5.4.A. Due 8 weeks after Deliverable 5.4.A.

#### **Task 6 – Further development of Maritime Biological Condition Gradient (BCG) community composition expectations**

This task will build on the Maritime Biological Condition Gradient (BCG) developed under TO # 68HERC20F0434, Task 4 and in coordination with OW, R10, and state/local partners to create community composition expectations in response to climate change effects such as stream temperature increases. Tasks include coordination with regional experts to assign taxa to thermal preference categories; R code updates to improve tolerance plots and statistical outputs; and the compilation of recommendations on approaches for reducing the subjectivity in plot interpretations.

***Deliverable 6.1:*** In coordination with regional experts, finalize thermal preference category assignments, using thermal thresholds where possible, for taxa in the Maritime BCG. Due 6 weeks after QAPP approval.

***Deliverable 6.2:*** Use Deliverable 6.1 to update existing Maritime BCG R code to predict membership in thermal groups and visualize thermal tolerance plots and membership over time. Due 4 weeks after Deliverable 6.1.

***Deliverable 6.3:*** Webinar with regional experts to present Deliverable 6.2, confirm the model of predicted membership with the BCG workgroup, and collect recommendations on approaches for reducing the subjectivity, reducing uncertainty/variability in predicted thermal groups, and improving consistency in plot interpretations. Due 3 weeks after Deliverable 6.2.



**Deliverable 6.4:** With input from the TOCOR to prioritize recommendations from the BCG workgroup, revise R code based on Deliverable 6.3. Due 4 weeks after Deliverable 6.3.

**Deliverable 6.5:** Build on preliminary inferred temperature model using macroinvertebrate data from OR and WA by selecting weighted average optima values, and deshrinking techniques, assessing model performance including the evaluation of removal or inclusion of rare or dominant taxa, and quantifying uncertainty. Due 10 weeks after QAPP approval.

**Deliverable 6.6:** Draft journal article describing the macroinvertebrate inferred temperature models (MIT) and BCG-style thermal preference model based on output from Deliverable 6.5. Due May 31, 2022.

**Deliverable 6.7:** Draft journal article integrating a climate component into the Maritime BCG to describe community composition shifts expected over time, including potential application to inform site selection decisions for protection and restoration, based on Deliverable 6.4. Due May 31, 2022.

### **Task 7 – Screening of potential changes in HAB risk for inland lakes in the U.S.**

This task is to produce national-scale screening of potential changes in cyanobacterial HAB risk for inland lakes in the conterminous U.S. Rather than a geographic focus (e.g., modeling specific lakes), the analysis will use relationships available in the literature (most of which are summarized by Rouso et al. 2020 <https://doi.org/10.1016/j.watres.2020.115959>) to draw conclusions about how climate change is likely to affect cyanobacterial HAB risk as a function of lake physical characteristics (e.g., depth, surface area, water clarity, hydraulic residence time) and nutrient loading in the watershed.

There is no standard, agreed upon approach for this type of analysis. The Contractor shall first develop a proposed, detailed plan for conducting the meta-analysis and submit for TOCOR review. The approach will focus on empirical or data-driven models, and to the extent possible can leverage existing ORD products including estimated responses of lake water temperature and vertical stability to climate forcing as a function of lake characteristics (Butcher et al., 2017; <https://doi.org/10.1371/journal.pone.0183499>), semi-quantitative statements about how nutrient loading to lakes is likely to change in response to climate from the 20 watersheds project (U.S. EPA 2013; <https://cfpub.epa.gov/ncea/global/recorddisplay.cfm?deid=256912>), a HABs evidence network linking information extracted from the literature to a conceptual diagram of hypothesized relationship between HABs, the conditions in which they form in freshwaters, and their effects (PR-ORD-19-02508/SOL68HERC20R0010), and results from the HAB forecast dataset compilation and lake classification work (PR-ORD-21-01680/TO 68HERC21R0202).

After TOCOR approval of the analysis plan, the Contractor shall review the technical literature and develop a meta-analysis to synthesize data-driven estimates in bloom risk in lakes in different physical and hydroclimatic settings. The contractor shall then apply the meta-analysis to estimate potential relative changes in HAB risk in different regions of the U.S. These would not be predictions for individual lakes; rather they would be predictions of how different lake

types in different regions of the U.S. are likely to respond, e.g., based on a set of lake “archetypes” defined by depth, surface area, water clarity and/or other physical characteristics for each region. The Contractor shall develop a manuscript and spatial dataset describing results.

*Deliverable 7.A:* Detailed plan for meta-analysis. Due to TOCOR 4 weeks after award.

*Deliverable 7.B:* Spatial datasets. Due to TOCOR 8 months after award.

*Deliverable 7.C:* Draft manuscript. Due to TOCOR 10 months after award.

*Deliverable 7.D:* Final manuscript. Due to TOCOR 12 months after award.

## **Task 8 – Development of Input Variables for Assessing Future Drinking Water Quality Violations**

### **Subtask 8.1 – Develop proposed list of variables**

The Contractor shall review Pennino et al. 2020 (<https://www.sciencedirect.com/science/article/pii/S0048969720311724>) and – in consultation with EPA – assess the feasibility of acquiring or reasonably estimating projections of those variables. The Contractor shall identify the location (e.g., web URL) of potential data as well as tools needed to process or otherwise prepare the information for input into a Random Forest Model as demonstrated in Pennino et al. 2020. Examples of variables the Contractor shall consider include: precipitation, temperature, hydrologic (e.g., baseflow, runoff), land use, land cover, nutrient deposition, and other nutrient inputs.

After reviewing the proposed list with EPA, the Contractor shall acquire and process selected data and prepare those data for input into a Random Forest Model, very similar to the method described in Pennino et al. 2020. All variables shall be summarized by HUC12 for the contiguous United States.

*Deliverable 8.1.* Draft list of proposed variables, noting reasons for inclusion or exclusion as a final selection. Due to TOCOR 6 weeks after final QAPP approval.

### **Subtask 8.2 – Finalize the list of variables**

The Contractor shall convene a conference call with EPA to discuss the variables proposed in Subtask 8.1, including, for each variable: the expected level of effort to acquire and process the data; potential limitations; and potential alternatives.

*Deliverable 8.2.* – Memo describing final list of proposed variables. Due to TOCOR 3 weeks after Draft variable list.

### **Subtask 8.3 – Acquire and process datasets**

After final approval by EPA (Subtask 8.2), the Contractor shall obtain and prepare the selected variables to serve as inputs into a Random Forest Model. All variables will be summarized by HUC12 for the contiguous United States. The Contractor shall electronically deliver all variables in commonly used tabular and geospatial formats.

***Deliverable 8.3:*** Input variables summarized by HUC12 and geospatial image format for the contiguous United States. Due to TOCOR 12 weeks after conference call.

## **Task 9 - Projecting the condition of biological communities nationwide with climate change, urbanization, and other land use changes**

Projected changes in climate, land use, land cover, and human populations have potential effects on instream biological communities. Recently, Van Metre et al. 2019 (<https://doi.org/10.1371/journal.pone.0222714>) developed regression models predicting the loss of sensitive fish and macroinvertebrate taxa in wadeable streams across the Piedmont region of the southeastern United States by applying ecological models to urbanization land-use projections. The Contractor shall develop a plan for expanding these modeled projections to the national-scale (i.e., conterminous U.S.) and explicitly including climate change scenarios and responses to climate-related variables for up to 3 (three) stream organisms (e.g., fish, macroinvertebrates, diatoms). The Contractor shall include in the plan statistical correlation analyses between urban-associated instream stressors (e.g., contaminants such as disinfectant byproducts, temperature, nutrients, flow alteration) and biological condition in an approach similar to Van Metre et al. 2019. The Contractor shall consider the inclusion of condition thresholds from EPA's National Rivers and Stream Assessments in the correlation analyses as part of developing the detailed plan (deliverable 9.1).

***Deliverable 9.A:*** Draft plan for analysis. Due to TOCOR 2 months after award.

***Deliverable 9.B:*** Detailed plan for analysis. Due to TOCOR 4 months after award.

***Deliverable 9.C:*** Spatial datasets. Due to TOCOR 8 months after award.

***Deliverable 9.D:*** Draft manuscript. Due to TOCOR 10 months after award.

## **VIII. SCHEDULE OF BENCHMARKS & DELIVERABLES:**

<b>Task No.</b>	<b>SubTask No.</b>	<b>DELIVERABLE</b>	<b>Incremental Schedule</b>
1	1.1	1.1.A. Monthly conference calls or as requested by the TOCOR	Due each month for the duration of this TO or as requested by the TOCOR

1	1.1	1.1.B. Each monthly conference call shall be reported in meeting notes as email	Due within 3 days after the monthly call
1	1.2	1.2.A. Draft QAPP	Due 14 days after TO award
1	1.2	1.2.B. Final QAPP	Due 1 week after TOCOR comments
2	2.1	2.1. Draft itemized list of priority needs and proposed updates/revisions to the WQCLR site	Due to TOCOR 8 weeks after award
2	2.2	2.2. Final itemized list and proposed updates/revisions to the WQCLR site	Due 8 weeks after receiving TOCOR comments on Deliverable 2.1.
3	3.1	3.1.A. Second draft “national screening stormwater” manuscript addressing EPA internal review comments	Due to TOCOR 4 weeks after receiving EPA internal peer review comments from the TOCOR.
3	3.1	3.1.B. Third draft “national screening stormwater” manuscript addressing journal peer review comments	Due to TOCOR 4 weeks after receiving peer review comments.
3	3.2	3.2.A. Second draft “BMP resilience” manuscript addressing peer review comments	Due to TOCOR 4 weeks after receiving peer review comments from the TOCOR.
3	3.2	3.2.B. Second draft “RDM” manuscript addressing peer review comments	Due to TOCOR 4 weeks after receiving peer review comments from the TOCOR.
4	4.1	4.1.A. Screening criteria for inclusion of wetland sites.	Due two (2) weeks after TO QAPP is approved.
4	4.1	4.1.B. Proposed list of sites based on Deliverable 4.1.A and map of those sites.	Due two (2) weeks after Deliverable 4.1.A approved.
4	4.1	4.1.C. Webinar with state partners to get input on screening criteria and proposed sites.	Due two (2) weeks after Deliverable 4.1.B approved.
4	4.2	4.2. Implement screening criteria and finalize proposed sites.	Due two (2) weeks after Deliverable 4.1 approved.
4	4.3	4.3.A. Draft indicator list and protocols to collect the data for those indicators.	Due one (1) month after Deliverable 4.2 approved.

4	4.3	4.3.B. Webinar with state partners to present draft indicator list and protocols.	Due two (2) weeks after receiving TOCOR comments on Deliverable 4.3.A.
4	4.4	4.4.A. Develop draft protocol documents based on Deliverable 4.3.B.	Due six (6) weeks after Deliverable 4.3.B.
4	4.4	4.4.B. Use Deliverable 4.4.A. to draft QAPP for state partners to use for data collection.	Due one (1) month after receiving TOCOR comments on Deliverable 4.4.A.
4	4.4	4.4.C. Webinar with state partners to discuss Deliverables 4.4.A. and 4.4.B.	Due two (2) weeks after receiving TOCOR comments on Deliverable 4.4.B.
4	4.4	4.4.D. Finalize protocol and QAPP documents based on Deliverable 4.4.C.	Due one (1) month after Deliverable 4.4.C.
4	4.5	4.5. Present network of sites to state partners.	Due two (2) weeks after receiving TOCOR comments on Deliverable 4.4.B.
5	5.1	5.1 Monthly RMN support memo	Due monthly
5	5.2	5.2 RMN partner data for EMVL	Due 8 weeks after QAPP approval
5	5.3	5.3 Presentations	Due three (3) weeks before each conference
5	5.4.A	5.4.A Webinar on R tool improvements	Due 12 weeks after QAPP approval
5	5.4.B	5.4.B Complete R tool improvements	Due 8 weeks after Deliverable 5.4.A
6	6.1	6.1 Final thermal preference category assignments for Maritime BCG	Due 6 weeks after QAPP approval
6	6.2	6.2 Update Maritime BCG R code	Due 4 weeks after Deliverable 6.1
6	6.3	6.3 Webinar to BCG workgroup	Due 3 weeks after Deliverable 6.2
6	6.4	6.4 Revised R code	Due 4 weeks after Deliverable 6.3
6	6.5	6.5 Preliminary inferred temperature model	Due 10 weeks after QAPP approval
6	6.6	6.6 Draft journal article describing inferred temperature model and thermal preference model	Due May 31, 2022
6	6.7	6.7 Draft journal article integrating climate component into Maritime BCG to describe community composition shifts	Due May 31, 2022

7	7	7.A. Detailed plan for meta-analysis	Due to TOCOR 4 weeks after award.
7	7	7.B. Spatial datasets	Due to TOCOR 8 months after award.
7	7	7.C. Draft manuscript	Due to TOCOR 10 months after award.
7	7	7.D. Final manuscript	Due to TOCOR 12 months after award.
8	8.1	8.1. Draft variable list	Due to TOCOR 6 weeks after final QAPP approval.
8	8.2	8.2. Conference call and final variables list	Due to TOCOR 3 weeks after Draft variable list.
8	8.3	8.3. Final variables	Due to TOCOR 12 weeks after conference call.
9	9	9.A. Draft plan for analysis	Due to TOCOR 2 months after award.
9	9	9.B Detailed plan for analysis	Due to TOCOR 4 months after award.
9	9	9.C. Spatial datasets	Due to TOCOR 8 months after award.
9	9	9.D. Draft manuscript	Due to TOCOR 10 months after award.

## IX. ACCEPTANCE CRITERIA:

The Contractor shall prepare high quality deliverables. Deliverables shall be edited for grammar, spelling, and logic flow. The technical information shall be reasonably complete and presented in a logical, readable manner. Figures submitted shall be of high quality, similar to those in presentations developed for national scientific meetings and should be formatted as jpeg or png files. Citation library deliverables shall be compatible with EndNote X7. Spreadsheet, report, and database deliverables shall be compatible with Microsoft Office 365 (i.e., MS Excel, MS Word, Adobe pdf, or MS Access files depending on the task and deliverable).

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